Space Weather Technical Forecast

Issued on Wednesday, 15 March 2023 at 00:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of Minor Geomagnetic storms due to possible glancing CMEs and CH84 enhancement on days 1 and 2 (15 and 16 March). S1/Minor Radiation storm expected on day 1 (15th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low or Very Low in the past 24 hours with isolated C-class flares. The peak flare a C3.0 at 14/0605UTC from AR3250. There are currently eight sunspot regions currently on the Earth-facing disc. These are a mixture of small, mature spots with a couple of small but emergent/developing regions. All spots however, are magnetically simple at present. There are also several filaments on the disc, which should any erupt, could be another source of C-class flares.

No Earth directed CME's have been observed in the past 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind observed at L1, has perhaps been indicative of a glancing transient or weak coronal hole fast wind arrival, with speeds increasing from 310km/s to 445 km/s between 14/0400-0900 UTC, before slowly easing back to near 400km/s. The density has been predominantly above average throughout, with a peak of 27ppcc at 14/0651 UTC. The total IMF strength was weak to moderate with a peak at 14/0431 UTC of 16nT. The north-south component was variable but often negative fluctuating between +13/-10nT. The Phi angle was mostly positive (away from the Sun) until 14/0945 UTC when occasional spells of negative (towards the Sun) developed. Geomagnetic activity was Quiet to Active (Kp 2-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16, has risen back above the S1 level, likely due to the ongoing effects from the significant far-sided eruption early on the 13th, with a peak of 18pfu at 14/2220UTC. The high energy electron flux (greater than 2MeV) has been at moderate to background levels, with a peak of 505pfu at 14/1450UTC. The associated 24 hour Electron fluence has remained below Active on a largely flat trend. At 15/0001UTC the observed fluence was 8.80e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to continue Low or Very Low, with a slight chance of an isolated M-class flare.

Solar Wind / Geomagnetic Activity: Glancing CME impacts are possible through 15 March, due to three filament eruptions that occurred 10-13 March. These are all low confidence, however any combined effect could give a larger geomagnetic response than normally expected from such glancing impacts. Otherwise, an average of slightly elevated solar winds are expected through much of the period, with a chance of becoming elevated due to the faster winds from CH84/+ early in the period. Quiet to Unsettled geomagnetic activity is expected, with possible Active intervals. The arrival of any CMEs will likely bring Active intervals with a chance of G1

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Minor Storm intervals from 15 March until 16 March, before easing to mainly Quiet by 17 March.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux, as observed by GOES16, is currently at S1/Minor Storm levels, but expected to gradually decline towards background levels through the period. The high energy electron flux is expected to persist at Background to Moderate levels, with faster winds from CH84/+ or any CME likely to continue suppressing flux. Flux levels are likely to rise more persistently towards Moderate by the end of the period. The associated 24 hour electron fluence is expected persist at below the Active level, likely declining initially.

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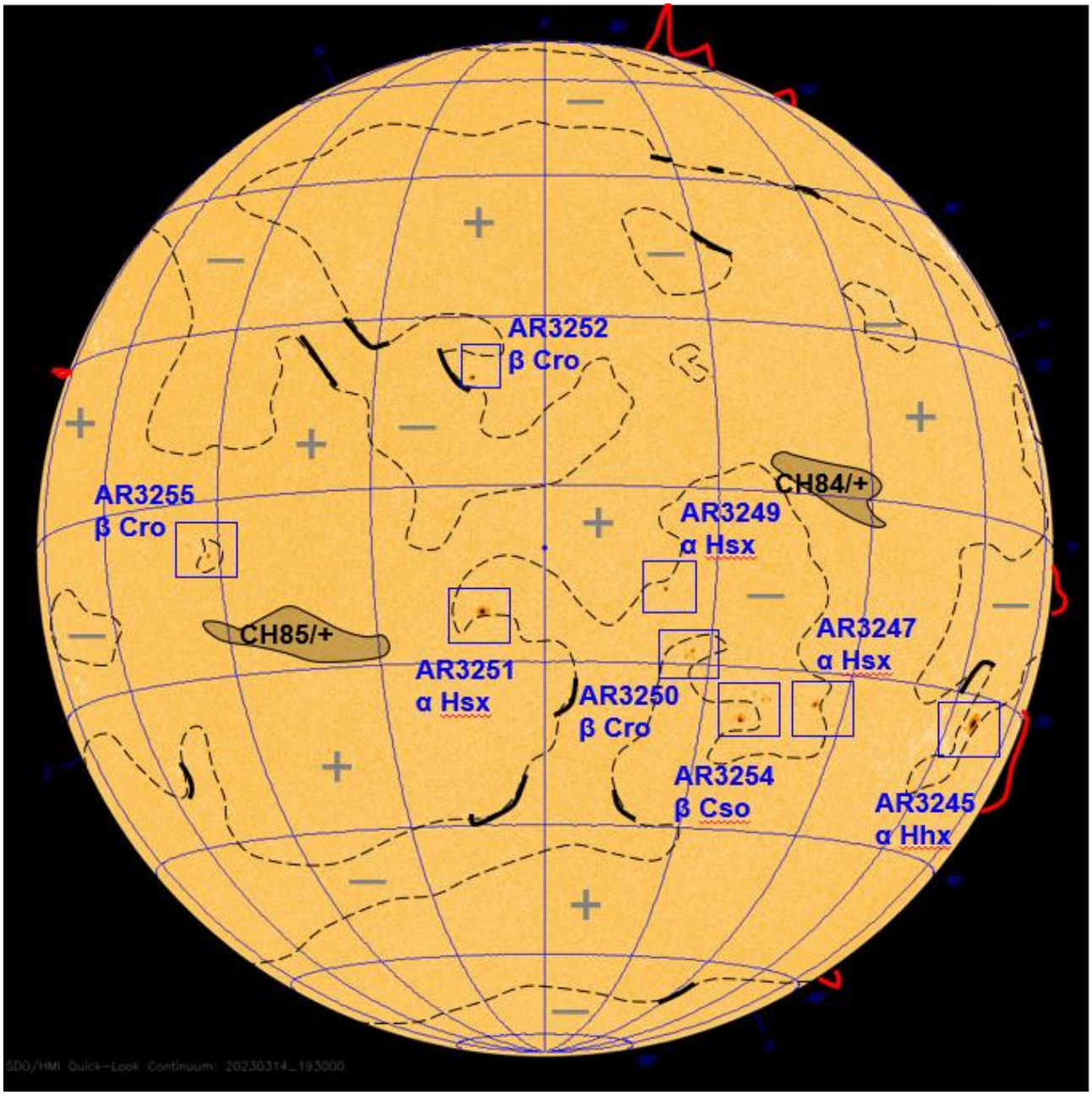
Figure 1. Solar Analysis Valid 14/2000UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are a number of possible CME arrivals, however all are low confidence. The first, from a filament eruption off the southwest quadrant on 10 March may pass close enough to Earth to give some glancing influence early on day 1 (15 March). A further filament eruption from the southeast disc on 12 March may then glance Earth late on day 1 (15 March). A faster filament eruption off the northwest disc later on the 12 March is also expected to pass largely north and ahead of Earth, however this too may give a glancing impact during day 1 (15 March), perhaps arriving earlier in the day.

Confidence in the impacts from these events is low, however given the number of CMEs potentially arriving in a period of 24 hours cumulative impacts may result in a stronger geomagnetic response than would normally be expected for such events.
Furthermore, the faster wind from CH84/+ may bring increased wind speeds to elevated, though this is not favoured for a strong connection around the March equinox due to the Russell Mcpherron effect. It may however aid increased activity levels given any CME arrival. Any faster wind and CME influence is expected to gradually recede later day 2 and 3 (16-17 March).
Quiet to Unsettled geomagnetic activity is expected, with possible Active intervals. The arrival of any CMEs will likely bring Active intervals with a chance of G1 Minor Storm intervals from 15 to 16 March, before easing to mainly Quiet by 17 March.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	40	30	1	1
Strong	G3	No	2	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/0102	Partial	Filament	SW	495km/s	Missing	Glance possible early 15th
12/2340	Partial	Filament	SE	760km/s	15/1800 +/- 6 hrs	Glancing impact
13/1319	Partial	Filament	N	1330km/s	15/1200 +/- 9 hrs	Likely passing over Earth, but chance of glancing

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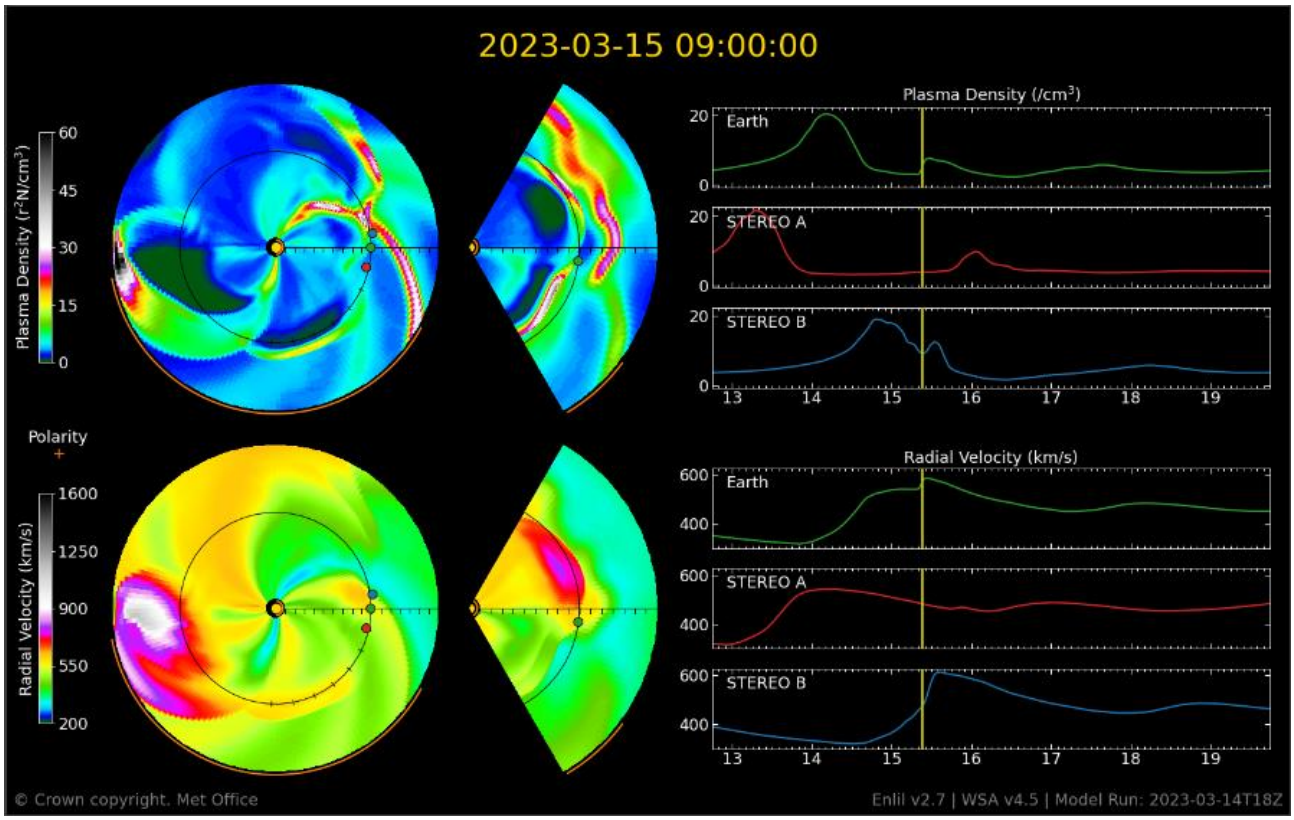
Figure 2: MOSWOC Enlil



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Radio Blackouts - X-Ray Flares:

Solar activity has been Low or Very Low in the past 24 hours with isolated C-class flares. The peak flare a C3.0 at 14/0605UTC from AR3250. There are currently eight sunspot regions currently on the Earth-facing disc. These are a mixture of small, mature spots with a couple of small but emergent/developing regions. All spots however, are magnetically simple at present. There are also several filaments on the disc, which should any erupt, could be another source of C-class flares.

Solar activity is expected to continue Low or Very Low, with a slight chance of an isolated M-class flare.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux has risen back above the S1 level, likely due to the ongoing effects from the significant far-sided eruption early on the 13th, with a peak of 18pfu at 14/2220UTC. Given the simplicity of the sunspots currently on the disc, no further enhancements are expected. A gradual decline in values back towards background is expected through the period, unless any further large far-sided eruptions occur.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	Yes	99	20	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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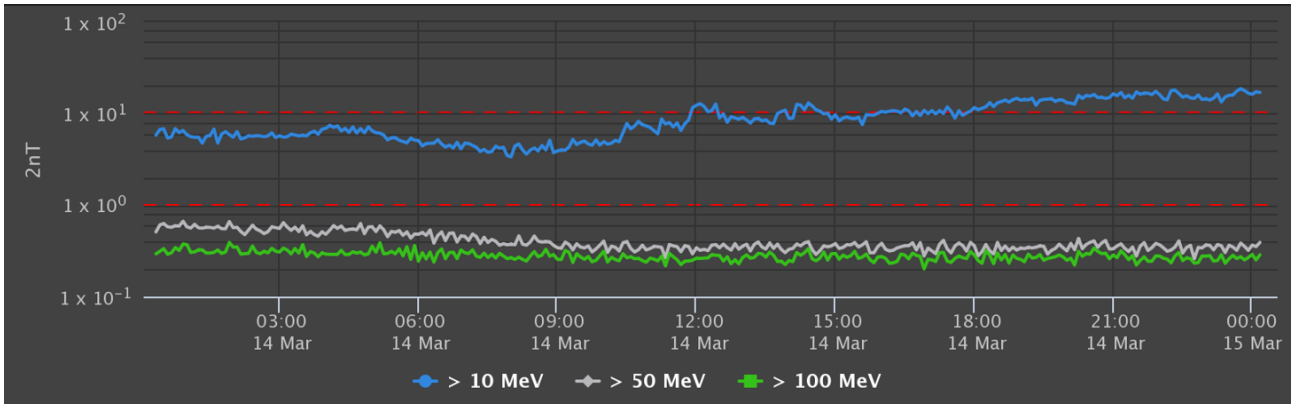
Figure 3: GOES 16 Proton flux over the past 24 hours



High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux at GEO, as observed by GOES-16, is expected to persist at Background to Moderate levels, with faster winds from CH84/+ or any CME likely to continue suppressing flux. Flux levels are likely to rise more persistently towards Moderate by the end of the period.

The associated 24 hour electron fluence is expected persist at below the Active level, likely declining initially. REFM is currently giving good guidance on expected conditions.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\,sr^{-1}\,day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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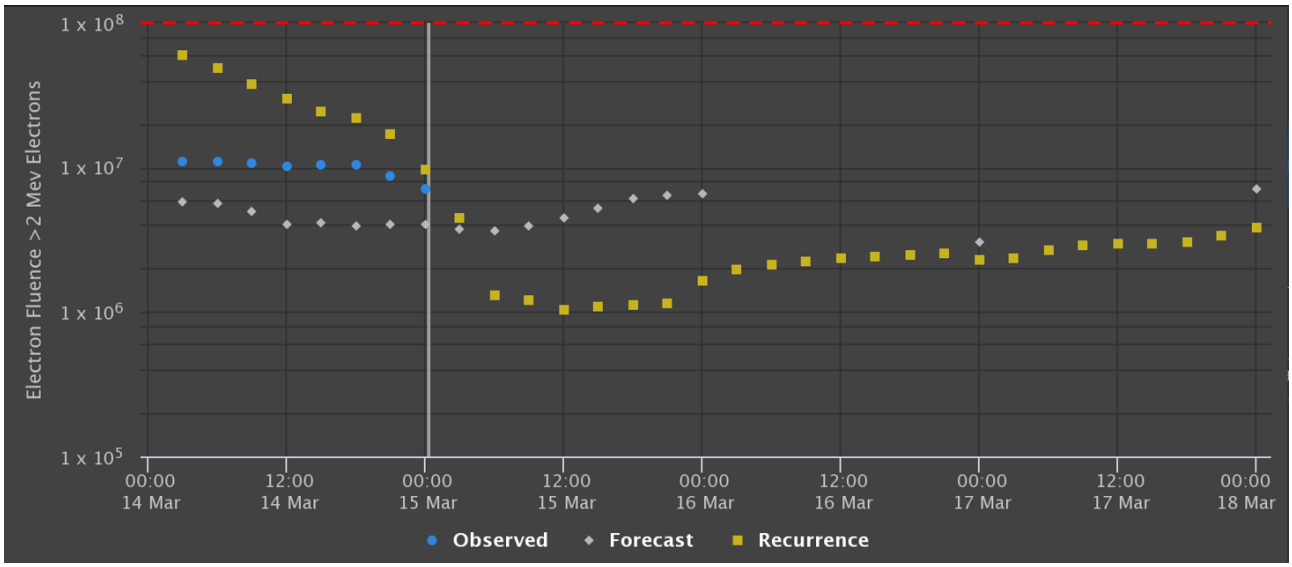
Figure 4: MOSWOC REFM



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